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Carotid Stenting Is Inferior to Carotid Endarterectomy in the Low Physiologic Risk Population: Results of the National Inpatient Sample, 2004-7

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Objective: The SAPPHIRE trial established that carotid artery stenting (CAS) is not inferior to carotid endarterectomy (CEA) for patients at high surgical risk. The CREST trial has shown CEA has a lower stroke rate than CAS, at the expense of higher cardiac complications. The objective of this study was to evaluate the nationwide performance of CAS and CEA in both high-risk (HR) and low-physiologic-risk (LR) patients, outside of the clinical trial setting.

Methods: Data from the National Inpatient Sample (NIS) were pooled for patients undergoing carotid intervention from 2004-2007. HR was defined as preexisting cardiac disease (CHF, valvular disease) or COPD. Stroke, death, myocardial infarction, and complication rates were determined in both HR and LR populations. Multivariate regression analysis was performed to determine adjusted odds of stroke and death.

Results: From 2004-2007, CEA was performed in 490,665 patients (HR, 30.6%) and CAS in 50,283 patients (HR, 31.2%). Unadjusted stroke/death rates were higher for CAS vs CEA in both HR and LR groups (Table). Myocardial infarction rates were equivalent in the HR population and slightly higher for CAS in the LR population. Combined complication rates were higher after CEA vs CAS, mainly due to pulmonary and renal complications. Multivariate regression analysis revealed adjusted odds of stroke/death were increased for CAS (OR, 1.36; CI, 1.28-1.45). HR patients had an equivalent odds of stroke/death after CAS (OR, 1.10; CI, 0.99-1.28), whereas LR patients had an increased odds (OR, 1.56; CI, 1.45-1.67).

Conclusions: This nationwide, real-world study supports the use of CAS in the HR population undergoing carotid intervention. However, the LR population is at higher risk of stroke and death after CAS compared with CEA. Contrary to the CREST results, both carotid procedures can be performed with equivalent cardiac morbidity.

EEG Monitoring with SSEP Obviates Need for Shunting in CEA, even with Stroke

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Objective: The utilization of selective cerebral shunting during carotid endarterectomy (CEA) has been predicated on surrogate measures such as contralateral carotid occlusion, back-pressure measurements, and the patient's motor and cognitive function with regional anesthesia or recent stroke. This study analyzed the need for shunting in CEA where comprehensive electroencephalography (EEG) monitoring with somatosensory evoked potentials (SSEP) was the sole determinant of the necessity of a shunt.

Design: A retrospective review was performed in a single institution of all consecutive CEAs performed between September 2002 and March 2010. The decision for carotid shunting was based only on changes in continuous EEG dynamics reflecting ischemia as assessed intraoperatively by a neurologist. SSEP were used in a portion of cases as a functional confirmation of EEG findings. No other factor influenced the need for a shunt. Patient demographics, including age, degree of internal carotid artery (ICA) stenosis, preoperative neurologic symptoms, and medications were reviewed. Thirty-day outcomes, including stroke, TIA, death, and other major complications were tabulated.

Results: A total of 163 patients (100 [62.5%] men; mean age 69.4 years, [range, 44-91]) underwent 169 carotid endarterectomies. Of the total arteries treated, 76 (45%) were symptomatic, of which 66 (39%) had a documented stroke. A total of 20 patients (11.8%) had high-grade contralateral (80%-99%) ICA stenosis and 12 (7%) had contralateral ICA occlusion. Only two shunts (1.2%) were used. The 30-day stroke, TIA, death rates were four (2.3%), zero (0%), and two (1.2%), respectively. There was one intraoperative stroke and the other three strokes occurred ≤30 days. None of the patients with contralateral occlusion or contralateral high-grade ICA stenosis had EEG changes necessitating a shunt.

Conclusion: Continuous EEG monitoring with SSEP dramatically reduces the need to place a shunt during CEA. Recent stroke, contralateral ICA occlusion, or contralateral high-grade ICA stenosis are not an indication for intraoperative shunting. Shunting for CEA should be vanishingly rare. EEG with SSEP should be considered the gold standard for monitoring of cerebral perfusion during CEA.

Spatial Distribution of Microemboli Following Carotid Interventions

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Background: Despite the absence of clinically evident neurologic symptoms, subclinical microemboli during carotid interventions are common. Characterizing the typical locations of these lesions is an important step in identifying neural systems vulnerable to disruption. The purpose of this study was to examine the distribution of microemboli after carotid interventions using a novel imaging analysis program.

Methods: Patients who received both preoperative and postoperative MRI evaluations for carotid interventions at a single academic institution from 2002 to 2008 were retrospectively evaluated. Microemboli were defined by new hyperintensities on postoperative diffusion-weighted MRI sequence (DWI) with corresponding decreased diffusion on the ADC map. Microemboli regions of interest (ROI) were manually defined (MRICron) and normalized using SPM5 along with ADC images. ROIs were smoothed using a conservative Gaussian distribution (FWHM = 6 mm) with FSL and input to a modified version of the Anatomic Likelihood Analysis (ALE) algorithm, in which a voxel-wise statistic was computed to derive a measure of agreement across images.

Results: Inter-rater reliability was first established between a board-certified neuroradiologist with experience detecting microemboli and a novice rater trained to adequate inter-rater reliability with respect to microembolus volume ($R^2 = 0.99$) and spatial overlap (similarity index = 0.80). Among 160 patients who underwent carotid interventions and received both preoperative and postoperative MRI studies, 81 had new postoperative DWI lesions. Areas with a high degree of convergence across ROIs included the anterior and posterior cingulate, middle frontal gyrus, insula, basal ganglia, and occipital areas (Brodmann areas 18 and 19; Fig).

Conclusion: Regions vulnerable to microemboli include those implicated in executive control and motor planning/speeded responses (anterior

Table. Chi-square analysis of carotid interventions

	High risk (165,741)			*Low risk (375,207)*		
Outcome, % (No.)	*CEA (150,053)*	*CAS (15,688)*	P	*CEA (340,612)*	*CAS(34,595)*	P
Stroke/death	4.60 (6908)	6.14 (964)	<.001	3.61 (12,286)	5.91 (2.044)	<.001
Stroke/death/MI	7.84 (11,765)	8.99 (1,410)	<.001	5.52 (18,797)	8.27 (2861)	<.001
Complications						
MI	3.61 (5416)	3.45 (541)	.312	2.06 (7.012)	2.66 (921)	<.001
Pulmonary	3.02 (4529)	1.01 (158)	<.001	1.04 (3540)	0.39 (136)	<.001
Renal	0.73 (1092)	0.41 (65)	<.001	0.72 (2437)	0.16 (54)	<.001
Combined	6.56 (9838)	4.52 (709)	<.001	3.56 (12,121)	3.12 (1081)	<.001